Safety in Numbers: An Emergency Stove for Melting Snow

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I’m a big fan of water, but I really hate to carry the stuff – it’s heavy. That’s one of the reasons that I love paddling a kayak: you just lean over the side of your boat to get water to purify. When hiking down low in many parts of the northeastern United States you run across enough lakes and streams so that you need to carry only a liter or two. But high up in our mountains, where the really great views live, water can be scarce.

In deep winter, though, those high mountains are usually covered in snow. On most winter hikes, I therefore carry exactly the amount of water I’ll need if all goes well, and then I bring along a canister stove and pot to melt snow in case I need more water. My particular stove and pot weigh about 18 ounces, including a full fuel canister. All the pieces pack into the pot, which has an insulating cozy on the sides to prevent convective heat loss and a heat exchanger below to facilitate heat transfer from the flame to the contents. The system is pricey – about $120 – but it is a great tool for melting snow down to about zero degrees.

I’ve recently assembled a smaller, lighter, less expensive stove that I carry in late fall through early spring on days when there is snow up high, but the temperatures are warmer. It will melt snow down to about twenty degrees, but probably take a lot longer to do so than its fancy cousin. But its weight (with fuel) is about half of the store-bought stove, and the parts together cost just a couple dollars. And it’s always fun to make your own gear.

The Gear

The left picture below shows my stove burning with a can that holds 13 ounces of water on top of it. Like most alcohol stoves, it is hard to see the flame in the light (be careful in daylight not to burn yourself!), so the middle picture was taken without a flash. You can see there the flame jets that are typical of alcohol stoves: the alcohol fuel is heated, and the vapor pressure of the heated alcohol causes it to exit through the holes, which turn into fuel jets.

The principles we learned in “Basics of Warmth” apply to stoves as well as people. The third picture shows the stove burning more efficiently, as it is protected from conductive heat loss to the ground by a base of reflective bubble wrap, and from convective heat loss to the air by a wind screen.

The components of the system are displayed in the image on the left. The top row shows the windscreen, the pot and the stove, and the bottom row shows the fuel bottle, the pot lid, and the base. The stove fits inside the pot, the fuel bottle fits inside that, the lid goes on the bottom of the pot, and the windscreen is folded in half and wrapped around the pot. The whole assembly is then placed into a zip-lock bag along with the base, and the result is shown on the left.

For more information about alcohol stoves in general, try searching the web for “alcohol stoves”. For the particular design that I used, search for “cat food can alcohol stove”. I started with an empty cat food can, cleaned it, then used a paper punch to put two lines of holes around the top. In under five minutes, I had a working alcohol stove.

The pot is made from a 13-ounce dog food can, cleaned well and with the sharp edges squeezed down by pliers. Because I’m only going to use this to melt snow, I decided to forego a handle, and just use a bandana to pick it up (the bottom is hot, but the top is cooled by the water it contains). The fuel bottle is an eight-ounce water bottle, clearly marked “for fuel only”. The eight fluid ounces of volume hold about 200 grams or 7 ounces (weight) of denatured alcohol. The wind screen and lid are both cut from a single-use aluminum tray from a dollar store, and the bubble wrap is from a Reflectix® roll that I originally bought for use as sleeping pads.

The stove weighs 7 grams and the pot weighs 43 grams. The wind screen weighs 12 grams, and the base and the lid each weigh 2 grams. The fuel bottle weighs 12 grams empty, and 212 grams with the eight fluid ounces of denatured alcohol. Toss in the zip-lock bag, and the whole kit and caboodle weighs 70 grams, or about 2½ ounces without fuel, and 282 grams, or 10 ounces, with fuel. I took both cans and the fuel bottle out of recycling, but if you add up the cost of the aluminum tray and the reflective bubble wrap, the whole setup comes to under two bucks.

Some Backyard Thermodynamics

If there is snow up high and the temperature is forecast to be well below freezing, I'll take along my fancy stove. But especially in late fall and early spring, some gloriously warm days have snow left on the ground. Will this rig melt snow in 20-degree temperature? And if so, how much? Time for some experiments. I performed them first on a 19-degree night, and then repeated them on a 22-degree evening. The results were pretty consistent.

My first experiment was to determine if the alcohol stove works at all. I lit the stove easily, and gave it thirty seconds for the alcohol fuel to heat up. I then measured how much time it took to bring eight ounces of tap water to a rolling boil using just the stove and the pot: about 10.5 minutes. Even though I don't plan to use this tool to boil water (its job is to melt snow), this tiny experiment convinced me that this stove produces ample heat in twenty-degree weather.

We know that heat can be lost through convection, conduction and radiation. I therefore added three aluminum components to the system to reduce heat loss: the base, the wind screen, and the lid. Those components address all three mechanisms of heat loss. My second experiment conclusively showed that the past few centuries of physics were not in vain: the time required to boil a cup of water was reduced from 10.5 minutes to 8.5 minutes. Those three objects together weigh less than half an ounce, and can save much more than their weight in fuel.

My third experiment was to see whether a fancier, store-bought alcohol stove would melt water even more efficiently. I found that a $25 titanium stove in fact boiled the cup of water in just 6 minutes, after I got the pesky thing started. But it was a genuine pain to start in 20-degree weather. I tried several times, and finally had to use a wick to preheat the alcohol for a few minutes before the jets finally cooked off. I prefer the less efficient but more reliable cat food can stove to the hotter but more persnickety store-bought variety.

The first three experiments used boiling water as a well-defined proxy for stove efficiency. The time to a rolling boil is an easy quantity to observe and to measure. My fourth and final experiment turned to job at hand: melting snow. I started with two ounces of cold water in the pot – always start with such water when you are melting snow. I found that 1¼ ounces of denatured alcohol (the maximum load in the stove) would burn for about 15 minutes and melt about 24 ounces of snow into 1½ pints of water.

The Bottom Line

When I head up a snowy peak on a warmish day, I have this 10-ounce emergency rig with me. I'll most likely never take it out of my pack. But if I do twist my knee and end up having to spend a night waiting for help, this will allow me to turn available snow into water. The little 8-ounce fuel bottle should be good for six 1¼ ounce burns of 15 minutes each. With any luck, I'll be able to melt about 9 pints or 4 liters of water in an hour and a half. That water could make the difference between a cold, dehydrated night and a warm, well-hydrated night.

Principles
Maybe some reader will build a similar emergency stove for their own use. That would be swell, but getting you to do-it-yourself isn't the point of this tale. The essence is the approach to problem solving: Identify an opportunity (in this case, replacing spare water with a stove to melt snow), and then build tools appropriate for the job. Conduct backyard experiments to measure the effectiveness of the components in appropriate conditions. Finally, quantify – as much as possible – the performance of the complete system.